TRS3232E ±15kV IEC ESD 保護機能搭載、小型パッケージの 3V～5.5V マルチチャネル RS-232 ライン ドライバ / レシーバ

1 特長

- RS-232 バス ピン用 ESD 保護機能
  - ±15kV (HBM)
  - ±8kV (IEC61000-4-2、接触放電)
  - ±15kV (IEC61000-4-2、気中放電)
- TIA/EIA-232-F および ITU V.28 規格の要件に適合またはそれを上回る性能
- 3V～5.5V の V_{CC} 電源で動作
  - V_{CC} が 2.7V まで下がっても RS-232 と相互運用可能
- 最大 250kbps で動作
- 2 つのドライバと 2 つのレシーバ
- 低い消費電流:300µA (標準値)
- 外付けコンデンサ:4 × 0.1µF
- 3.3V 電源で 5V ロジック入力を許容
- SOIC-16 よりも 85% 小さいニア チップ スケール パッケージ (QFN-16、3mm x 3mm) で供給
- 代替の高速デバイス (1Mbps) とピン互換
  - SN65C3232E (–40℃～+85℃)
  - SN75C3232E (0℃～70℃)

2 アプリケーション

- 産業用 PC
- 有線ネットワーク
- データ・センターおよびエンタープライズ・コンピューティング
- バッテリ駆動システム
- ノートブック PC
- パームトップ PC
- ハンドヘルド機器

3 概要

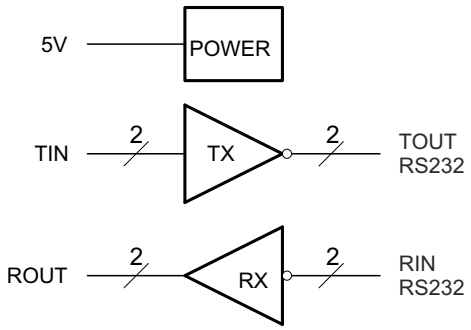
TRS3232E デバイスは 2 つのライン ドライバ、2 つのライン レシーバ、1 つのデュアル チャージ ポンプ回路で構成されており、ピン間 (シリアル ポート接続ピン、GND を含む) に ±15kV の IEC ESD 保護機能を備えています。

このデバイスは、TIA/EIA-232-F の要件を満たし、非同期通信コントローラとシリアルポート コネクタの間の電気的インターフェイスとして機能します。チャージ ポンプと 4 つの小さな外付けコンデンサにより、3V～5.5V の単一電源で動作できます。本デバイスは最大 250kbps/s のデータ信号速度、最大 30V/µs のドライバ出力スルーレートで動作します。

パッケージ情報

部品番号	パッケージ (1)	パッケージ サイズ(2)
TRS3232E	SOIC (D、16)	9.9mm × 6mm
	SSOP (DB、16)	6.2mm × 7.8mm
	SOIC (DW、16)	10.3mm × 10.3mm
	TSSOP (PW、16)	5mm × 6.4mm
	VQFN (RGT、16)	3 mm × 3mm
	SOT-23-THN (DYY) (16)	4.2mm × 2mm

(1) 詳細については、セクション 11 を参照してください。
(2) パッケージ サイズ (長さ × 幅) は公称値で、該当する場合はピンも含まれます。



簡略ブロック図

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4 Pin Configuration and Functions

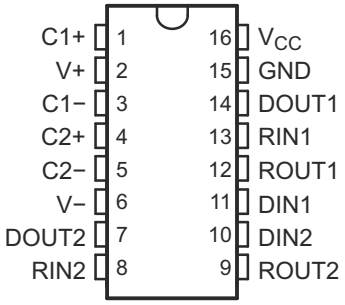


図 4-1. DB, PW or DYY Package 16-Pin SSOP, TSSOP, or SOT-23-THN (Top View)

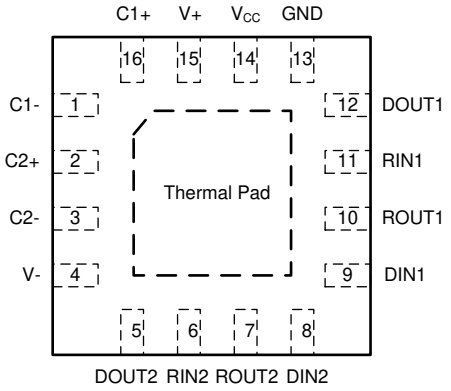


図 4-2. RGT package, 16 Pin VQFN, Top View

表 4-1. Pin Functions

PIN			TYPE	DESCRIPTION
NAME	NO.	RGT		
C1+	1	16	—	Positive lead of C1 capacitor
C1–	3	1	—	Negative lead of C1 capacitor
C2+	4	2	—	Positive lead of C2 capacitor
C2–	5	3	—	Negative lead of C2 capacitor
DIN1	11	9	I	Logic data input (from UART)
DIN2	10	8	I	Logic data input (from UART)
DOUT2	7	5	O	RS232 line data output (to remote RS232 system)
DOUT1	14	12	O	RS232 line data output (to remote RS232 system)
GND	15	13	—	Ground
RIN1	13	11	I	RS232 line data input (from remote RS232 system)
RIN2	8	6	I	RS232 line data input (from remote RS232 system)
ROUT2	9	7	O	Logic data output (to UART)
ROUT1	12	10	O	Logic data output (to UART)
V+	2	15	O	Positive charge pump output for storage capacitor only
V–	6	4	O	Negative charge pump output for storage capacitor only
V_{CC}	16	14	—	Supply voltage, connect to external 3-V to 5.5-V power supply
Thermal Pad		Yes	—	Thermal pad for improving heat dissipation. Can be connected to GND or left floating.

5 Specifications

5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

			MIN	MAX	UNIT
V_{CC}	Supply voltage(2)		–0.3	6	V
V+	Positive output supply voltage(2)		–0.3	7	V
V–	Negative output supply voltage(2)		0.3	–7	V
V+ – V–	Supply voltage difference(2)			13	V
V_I	Input voltage	Drivers	–0.3	6	V
		Receivers	–25	25	V
V_O	Output voltage	Drivers	–13.2	13.2	V
		Receivers	–0.3	V_{CC} + 0.3	V
T_J	Operating virtual junction temperature			150	°C
T_{stg}	Storage temperature		–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltages are with respect to network GND.

5.2 ESD Ratings

				VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	All pins except RIN1, RIN2, DOUT1 and DOUT2	±2000	V
			Pins RIN1, RIN2, DOUT1 and DOUT2	±15000	
		Charged-device model (CDM), per JEDEC specification JESD22-C101(2)	All pins	±1500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

5.3 ESD Ratings - IEC Specifications

				VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	IEC 61000-4-2, Contact Discharge(1)	Pins RIN1, RIN2, DOUT1, DOUT2(2)	±8000	V
		IEC 61000-4-2, Air-Gap Discharge(1)	Pins RIN1, RIN2, DOUT1, DOUT2(2)	±15000	

(1) For RGT, D, DB and PW packages only: Minimum of 1-µF capacitor between VCC and GND is required to meet the specified IEC 61000-4-2 rating.
(2) For optimized IEC ESD performance for DYY package, the recommendation is to have series resistor (≥ 50Ω), on all logic inputs directly connected to power or ground, to minimize the transient currents going into or out of the logic pins.

5.4 Recommended Operating Conditions

See 図 8-1.(1)

				MIN	NOM	MAX	UNIT
	Supply voltage		V_{CC} = 3.3 V	3	3.3	3.6	V
			V_{CC} = 5 V	4.5	5	5.5	
V_{IH}	Driver high-level input voltage	DIN	V_{CC} = 3.3 V	2		5.5	V
			V_{CC} = 5 V	2.4		5.5	
V_{IL}	Driver low-level input voltage	DIN		0		0.8	V
V_I	Receiver input voltage	RIN		–25		25	V
T_A	Operating free-air temperature		TRS3232EC	0		70	°C
			TRS3232EI	–40		85	

(1) C1–C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.

5.5 Thermal Information

THERMAL METRIC(1)		TRS3232E						UNIT
		PW (TSSOP)	D (SOIC)	DW (SOIC)	DB (SSOP)	RGT (VQFN)	DYY (SOT-23-THN)	
		16 PINS	16 PINS	16 PINS	16 PINS	16 PINS	16 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	108.2	85.9	72.3	103.1	48.8	106.2	°C/W
$R_{\theta JCtop}$	Junction-to-case (top) thermal resistance	39.0	43.1	33.5	49.2	55.8	47.4	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	54.4	44.5	37.1	54.8	23.2	44.7	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	3.3	10.1	7.5	12.0	1.7	1.7	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	53.8	44.1	37.1	54.1	23.2	43.7	°C/W
$R_{\theta JCbot}$	Junction-to-case (bottom) thermal resistance	N/A	N/A	N/A	N/A	9.0	N/A	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, SPRA953.

5.6 Electrical Characteristics — Device

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see 図 8-1).(1)

PARAMETER		TEST CONDITIONS	MIN	TYP(2)	MAX	UNIT
I_{CC}	Supply current	No load, V_{CC} = 3.3 V or 5 V		0.3	1	mA

(1) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.
(2) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

5.7 Electrical Characteristics — Driver

over operating free-air temperature range (unless otherwise noted) (see 図 8-1).(1)

PARAMETER		TEST CONDITIONS		MIN	TYP(2)	MAX	UNIT
V_{OH}	High-level output voltage	DOUT at R_L = 3 kΩ to GND,	DIN = GND	5	5.4		V
V_{OL}	Low-level output voltage	DOUT at R_L = 3 kΩ to GND,	DIN = V_{CC}	–5	–5.4		V
I_{IH}	High-level input current	V_I = V_{CC}			±0.01	±1	µA
I_{IL}	Low-level input current	V_I at GND			±0.01	±1	µA
I_{OS} (3)	Short-circuit output current	V_{CC} = 3.6 V,	V_O = 0 V		±35	±60	mA
		V_{CC} = 5.5 V,	V_O = 0 V				
r_O	Output resistance	V_{CC}, V+, and V– = 0 V,	V_O = ±2 V	300	10M		Ω

(1) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.
(2) Short-circuit durations should be controlled to prevent exceeding the device absolute power dissipation ratings, and not more than one output should be shorted at a time.
(3) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

5.8 Electrical Characteristics — Receiver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see 図 8-1).(2)

PARAMETER		TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
V_{OH}	High-level output voltage	I_{OH} = –1 mA	V_{CC} – 0.6	V_{CC} – 0.1		V
V_{OL}	Low-level output voltage	I_{OL} = 1.6 mA			0.4	V
V_{IT+}	Positive-going input threshold voltage	V_{CC} = 3.3 V		1.5	2.4	V
		V_{CC} = 5 V		1.8	2.4	
$V_{IT–}$	Negative-going input threshold voltage	V_{CC} = 3.3 V	0.6	1.2		V
		V_{CC} = 5 V	0.8	1.5		
V_{hys}	Input hysteresis (V_{IT+} – $V_{IT–}$)			0.3		V
r_i	Input resistance	V_I = ±3 V to ±25 V	3	5	7	kΩ

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.

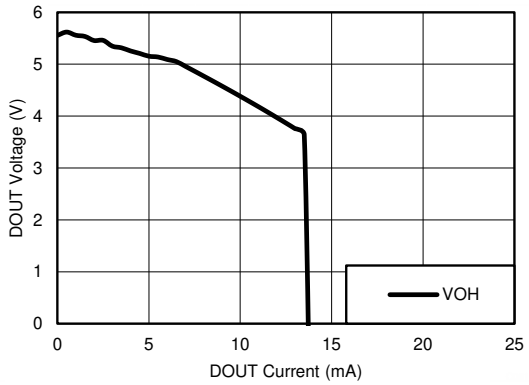
5.9 Switching Characteristics

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see 図 8-1)(1)

PARAMETER		TEST CONDITIONS		MIN	TYP(2)	MAX	UNIT
	Maximum data rate	R_L = 3 kΩ, C_L = 1000 pF, see 図 6-1 One DOUT switching,	RGT package	250	500		kbps
			D, DB, DW and PW packages	150	250		
$t_{sk(p)}$	Driver pulse skew(3)	R_L = 3 kΩ, C_L = 1000 pF, V_{CC} = 5 V 図 6-2	RGT package		50		ns
		R_L = 3 kΩ to 7 kΩ, C_L = 150 pF to 2500 pF see 図 6-2	D, DB, DW and PW packages		300		
SR(tr)	Driver slew rate, transition region (see 図 6-1)	R_L = 3 kΩ to 7 kΩ, V_{CC} = 3.3 V	C_L = 150 pF to 1000 pF	6		30	V/µs
			C_L = 150 pF to 2500 pF	4		30	
t_{PLH}	Receiver propagation delay time, low- to high-level output	C_L = 150 pF, see 図 6-3	RGT package		90		ns
			D, DB, DW and PW packages		300		
t_{PHL}	Receiver propagation delay time, high- to low-level output	C_L = 150 pF, see 図 6-3	RGT package		100		ns
			D, DB, DW and PW packages		300		
$t_{sk(p)}$	Receiver pulse skew(3)	RGT package			20		ns
		D, DB, DW and PW packages			300		

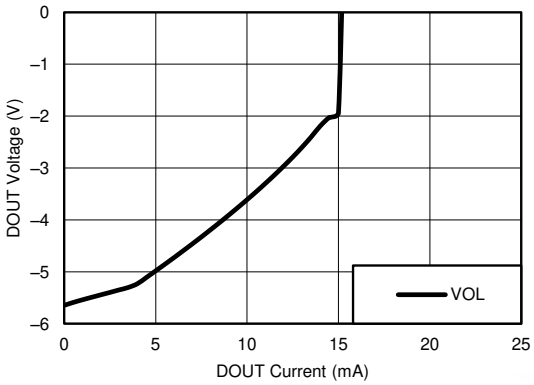
(1) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.
(2) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(3) Pulse skew is defined as $|t_{PLH} – t_{PHL}|$ of each channel of the same device.

Typical Characteristics



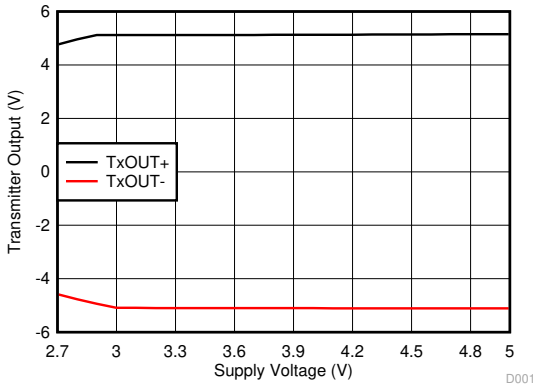
V_{CC} = 3.3V

図 5-1. DOUT V_{OH} vs Load Current, Both Drivers Loaded



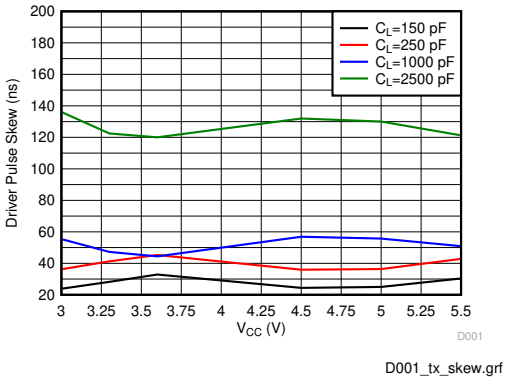
V_{CC} = 3.3V

図 5-2. DOUT V_{OL} vs Load Current, Both Drivers Loaded



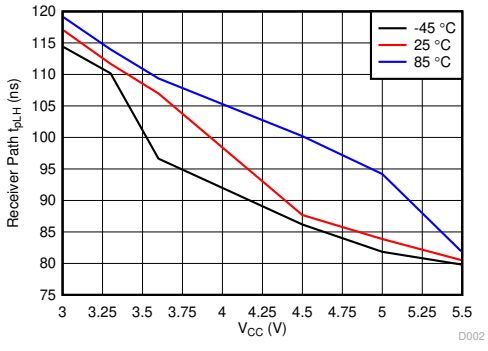
TX1 at 250kbps TX2 at 15.6kbps
Both TX loaded 3kΩ and 100pF

図 5-3. Driver Output Voltage vs. Supply Voltage, Both Drivers Loaded



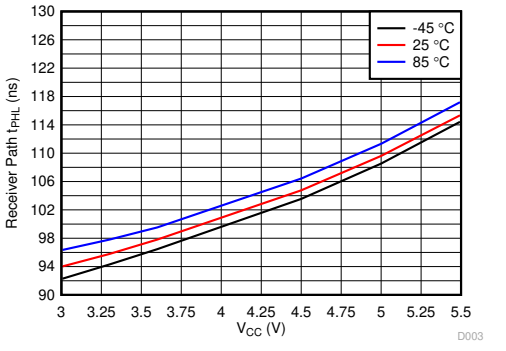
D001_tx_skew.grf

図 5-4. Driver Pulse Skew (RGT Package)



D002_rx_tpLH.grf

図 5-5. Receiver Path Low-to-High Propagation Delay (RGT Package)



D003_rx_tpHL.grf

図 5-6. Receiver Path High-to-Low Propagation Delay (RGT Package)

Typical Characteristics

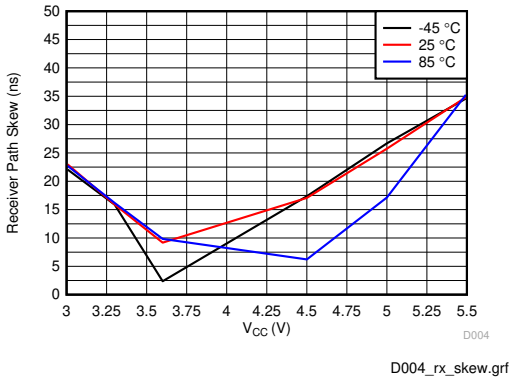
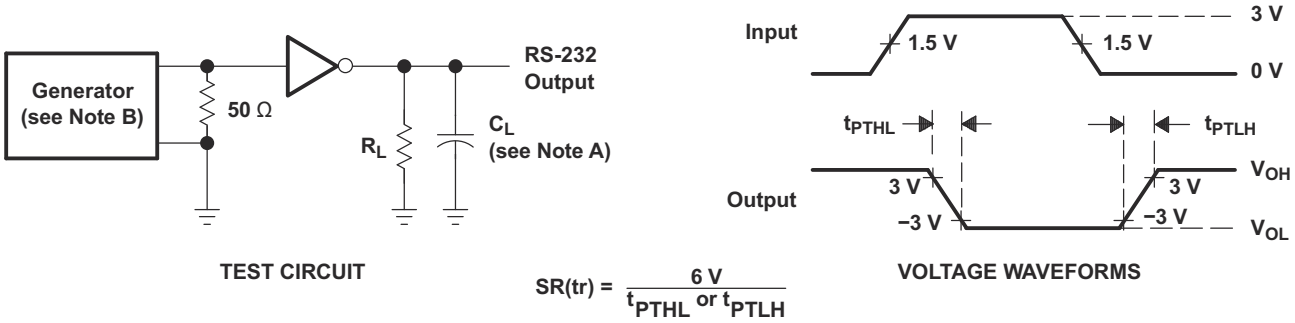


図 5-7. Receiver Path Skew ($|t_{pHL}-t_{pLH}|$) (RGT Package)

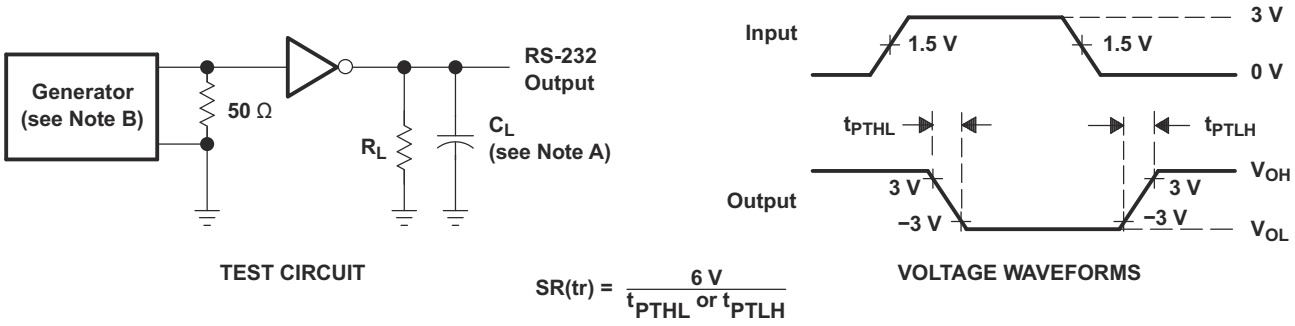
6 Parameter Measurement Information



A. C_L includes probe and jig capacitance

B. The pulse generator has the following characteristics: PRR = 250 kbps, Z_O = 50 Ω, 50% duty cycle, t_r ≤ 10 ns, t_f ≤ 10 ns

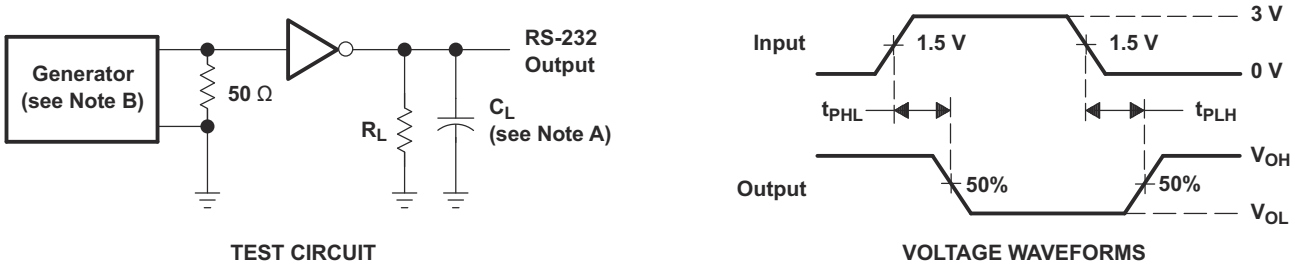
図 6-1. Driver Slew Rate



A. C_L includes probe and jig capacitance

B. The pulse generator has the following characteristics: PRR = 250 kbps, Z_O = 50 Ω, 50% duty cycle, t_r ≤ 10 ns, t_f ≤ 10 ns

図 6-2. Driver Pulse Skew



A. C_L includes probe and jig capacitance

B. The pulse generator has the following characteristics: Z_O = 50 Ω, 50% duty cycle, t_r ≤ 10 ns, t_f ≤ 10 ns

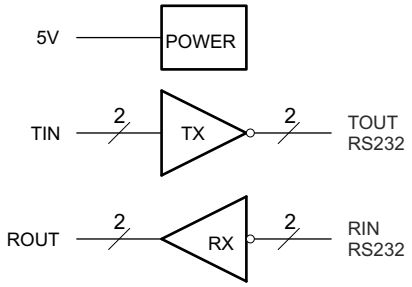
図 6-3. Receiver Propagation Delay Times

7 Detailed Description

7.1 Overview

The TRS3232E device consists of two line drivers, two-line receivers, and a dual charge-pump circuit with IEC61000-4-2 ESD protection terminal to terminal (serial-port connection terminals, including GND). The device meets the requirements of TIA/EIA-232-F and provides the electrical interface between an asynchronous communication controller and the serial-port connector. The charge pump and four small external capacitors allow operation from a single 3V to 5.5V supply. The device operates at data signaling rates up to 250kbps and a maximum of 30V/µs driver output slew rate. Outputs are protected against shorts to ground.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Power

The power block increases, inverts, and regulates voltage at V+ and V– pins using a charge pump that requires four external capacitors.

7.3.2 RS232 Driver

Two drivers interface standard logic level to RS232 levels. Both DIN inputs must be valid high or low.

7.3.3 RS232 Receiver

Two receivers interface RS232 levels to standard logic levels. An open input will result in a high output on ROUT. Each RIN input includes an internal standard RS232 load.

7.4 Device Functional Modes

表 7-1 and 表 7-2 list the functional modes of the drivers and receivers of TRS3232E.

表 7-1. Each Driver (1)

INPUT DIN	OUTPUT DOUT
L	H
H	L

(1) H = high level, L = low level

表 7-2. Each Receiver (1)

INPUT RIN	OUTPUT ROUT
L	H
H	L
Open	H

(1) H = high level, L = low level,
Open = input disconnected or connected driver off

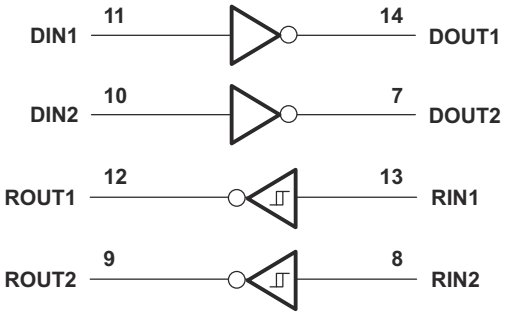


図 7-1. Logic Diagram

7.4.1 V_{CC} Powered by 3V to 5.5V

The device is in normal operation.

7.4.2 V_{CC} Unpowered, V_{CC} = 0V

When TRS3232E is unpowered, it can be safely connected to an active remote RS232 device.

8 Application and Implementation

注

以下のアプリケーション情報は、TI の製品仕様に含まれるものではなく、TI ではその正確性または完全性を保証いたしません。個々の目的に対する製品の適合性については、お客様の責任で判断していただくことになります。お客様は自身の設計実装を検証しテストすることで、システムの機能を確認する必要があります。

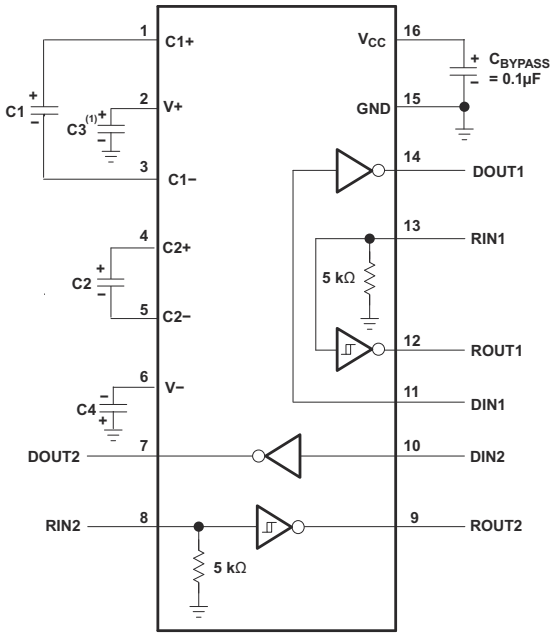
8.1 Application Information

The TRS3232E interfaces logic lines from a UART or microcontroller to the voltage and current levels needed for RS232 communication. The TIN inputs will accept 5V logic with 3.3V V_{CC} supply. All baud rates up to 250kbps are supported.

It is important to use the correct capacitors for the VCC voltage. This will reduce ripple voltage on the TOUT outputs. If only one driver is needed, the unused driver input should be connected to V_{CC} or ground.

8.2 Typical Application

ROUT and DIN connect to UART or general-purpose logic lines. RIN and DOUT lines connect to a RS232 connector or cable. For proper operation, add capacitors as shown in 表 8-1.



A. C3 can be connected to V_{CC} or GND
Resistor values shown are nominal.
Nonpolorized ceramic capacitors are acceptable. If polarized tantalum or electrolytic capacitors are used, they should be connected as shown.

図 8-1. Typical Operating Circuit and Capacitor Values

表 8-1. V_{CC} vs Capacitor Values

V_{CC}	C1	C2, C3, C4
3.3V ± 0.3V	0.1µF	0.1µF
5V ± 0.5V	0.047µF	0.33µF
3V ± 5.5V	0.1µF	0.47µF

8.2.1 Design Requirements

The recommended V_{CC} is 3.3V or 5V. 3V to 5.5V is also possible.

The maximum recommended bit rate is 250kbps.

8.2.2 Detailed Design Procedure

All DIN inputs must be connected to valid low or high logic levels.

Select capacitor values based on V_{CC} level for best performance.

8.2.3 Application Curve

図 8-2 curves are for 3.3V VCC and 250kbps alternative bit data stream.

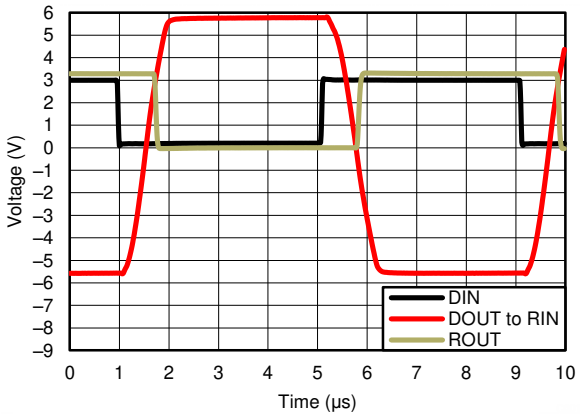


図 8-2. 250kbps Driver to Receiver Loopback Timing Waveform, V_{CC}= 3.3V

8.3 Power Supply Recommendations

The supply voltage, V_{CC}, should be between 3V and 5.5V. Select the values of the charge-pump capacitors using 表 8-1.

8.4 Layout

8.4.1 Layout Guidelines

Keep the external capacitor traces short, specifically on the C1 and C2 nodes that have the fastest rise and fall times.

8.4.2 Layout Example

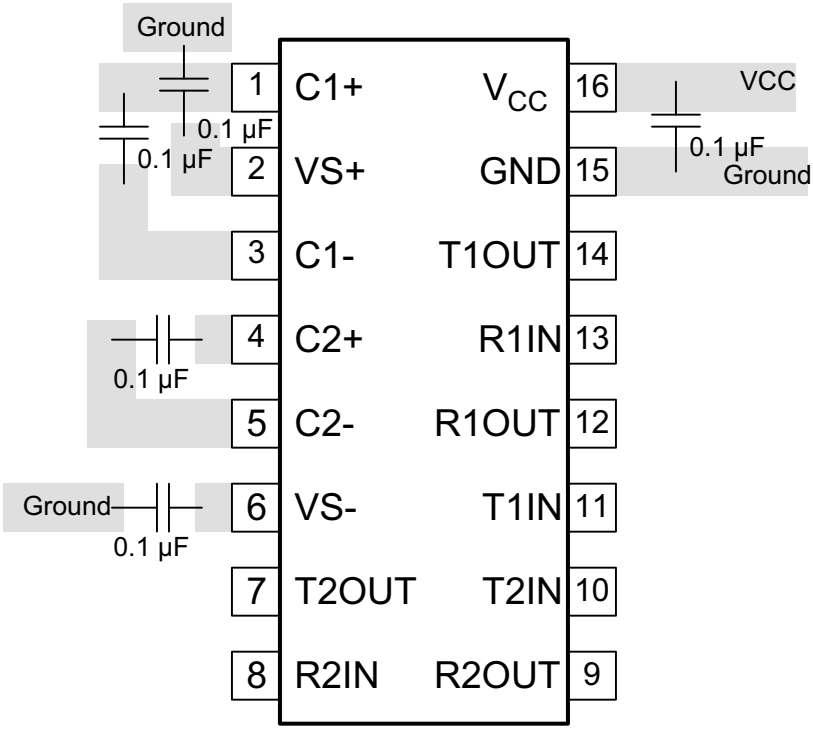


図 8-3. Layout Diagram

9 Device and Documentation Support

9.1 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、www.tij.co.jp のデバイス製品フォルダを開いてください。[通知] をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取ることができます。変更の詳細については、改訂されたドキュメントに含まれている改訂履歴をご覧ください。

9.2 サポート・リソース

テキサス・インスツルメンツ E2E™ サポート・フォーラムは、エンジニアが検証済みの回答と設計に関するヒントをエキスパートから迅速かつ直接得ることができる場所です。既存の回答を検索したり、独自の質問をしたりすることで、設計で必要な支援を迅速に得ることができます。

リンクされているコンテンツは、各寄稿者により「現状のまま」提供されるものです。これらはテキサス・インスツルメンツの仕様を構成するものではなく、必ずしもテキサス・インスツルメンツの見解を反映したものではありません。テキサス・インスツルメンツの使用条件を参照してください。

9.3 商標

テキサス・インスツルメンツ E2E™ is a trademark of Texas Instruments.
すべての商標は、それぞれの所有者に帰属します。

9.4 静電気放電に関する注意事項

この IC は、ESD によって破損する可能性があります。テキサス・インスツルメンツは、IC を取り扱う際には常に適切な注意を払うことを推奨します。正しい取り扱いおよび設置手順に従わない場合、デバイスを破損するおそれがあります。

ESD による破損は、わずかな性能低下からデバイスの完全な故障まで多岐にわたります。精密な IC の場合、パラメータがわずかに変化するだけで公表されている仕様から外れる可能性があるため、破損が発生しやすくなっています。

9.5 用語集

テキサス・インスツルメンツ用語集　　この用語集には、用語や略語の一覧および定義が記載されています。

10 Revision History

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

Changes from Revision D (June 2021) to Revision E (December 2024)	Page
• 「製品情報」表を「パッケージ情報」表に変更	1
• データシートに SOT-23-THN (DYY) パッケージを追加	1
• Added Note 2 to the *ESD ratings - IEC Specifications*	4

Changes from Revision C (June 2021) to Revision D (June 2021)	Page
• 「アプリケーション」を追加産業用 PC、有線ネットワーク、データ・センター、エンタープライズ・コンピューティング	1
• Changed the table note in the *ESD Ratings - IEC Specifications* to make it applicable to D, DB and PW packages.	4
• Changed the thermal parameter values for D, DB and PW packages in the *Thermal Information* table	5

Changes from Revision B (October 2017) to Revision C (June 2021)	Page
• *製品情報に RGT パッケージを追加*	1
• Added the RGT *Pin Configuration*	3
• Added the *ESD Ratings - IEC Specifications*	4
• Added RGT to the *Thermal Information*	5
• Added RGT package to the *Switching Characteristics*	7

- Changed the capacitor value From: 1 µf To: 0.1 µf in the *Layout Diagram* 15

Changes from Revision A (July 2015) to Revision B (October 2017) **Page**

- 「特長」に以下を追加：V_{CC} が 2.7V まで下がっても RS-232 と相互運用可能..... 1
- Added 図 5-3 8

Changes from Revision * (April 2007) to Revision A (July 2015) **Page**

- 「注文情報」表を削除。..... 1
- 「*製品情報*」表、「*ピン構成および機能*」セクション、「*ESD 定格*」表、「*熱に関する情報*」表、「*機能説明*」セクション、「*デバイスの機能モード*」、「*アプリケーションと実装*」セクション、「*電源に関する推奨事項*」セクション、「*レイアウト*」セクション、「*デバイスおよびドキュメントのサポート*」セクション、「*メカニカル、パッケージ、および注文情報*」セクションを追加。..... 1

11 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser based versions of this data sheet, refer to the left hand navigation.

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TRS3232ECDR	Active	Production	SOIC (D) | 16	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	TRS3232EC
TRS3232ECDR.A	Active	Production	SOIC (D) | 16	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	TRS3232EC
TRS3232ECDW	Obsolete	Production	SOIC (DW) | 16	-	-	Call TI	Call TI	0 to 70	TRS3232EC
TRS3232ECDWR	Active	Production	SOIC (DW) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	TRS3232EC
TRS3232ECDWR.B	Active	Production	SOIC (DW) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	TRS3232EC
TRS3232ECPWR	Active	Production	TSSOP (PW) | 16	2000 | LARGE T&R	Yes	NIPDAU | SN	Level-1-260C-UNLIM	0 to 70	RS32EC
TRS3232ECPWR.A	Active	Production	TSSOP (PW) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	RS32EC
TRS3232EIDBR	Active	Production	SSOP (DB) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	RS32EI
TRS3232EIDBR.A	Active	Production	SSOP (DB) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	RS32EI
TRS3232EIDR	Active	Production	SOIC (D) | 16	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TRS3232EI
TRS3232EIDR.A	Active	Production	SOIC (D) | 16	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TRS3232EI
TRS3232EIDRG4	Active	Production	SOIC (D) | 16	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TRS3232EI
TRS3232EIDRG4.A	Active	Production	SOIC (D) | 16	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TRS3232EI
TRS3232EIDW	Obsolete	Production	SOIC (DW) | 16	-	-	Call TI	Call TI	-40 to 85	TRS3232EI
TRS3232EIDWR	Obsolete	Production	SOIC (DW) | 16	-	-	Call TI	Call TI	-40 to 85	TRS3232EI
TRS3232EIDYYR	Active	Production	SOT-23-THIN (DYY) | 16	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	RS32EI
TRS3232EIDYYR.A	Active	Production	SOT-23-THIN (DYY) | 16	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	RS32EI
TRS3232EIPWR	Active	Production	TSSOP (PW) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	RS32EI
TRS3232EIPWR.A	Active	Production	TSSOP (PW) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	RS32EI
TRS3232EIPWRG4	Active	Production	TSSOP (PW) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	RS32EI
TRS3232EIRGTR	Active	Production	VQFN (RGT) | 16	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	3232
TRS3232EIRGTR.A	Active	Production	VQFN (RGT) | 16	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	3232

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

OTHER QUALIFIED VERSIONS OF TRS3232E :

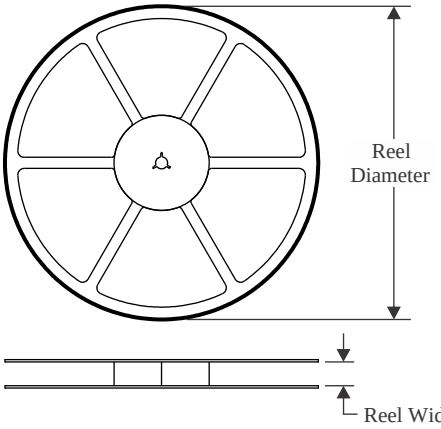
- Automotive : TRS3232E-Q1

NOTE: Qualified Version Definitions:

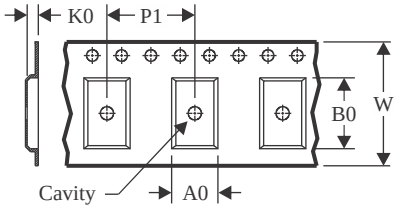
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION

REEL DIMENSIONS

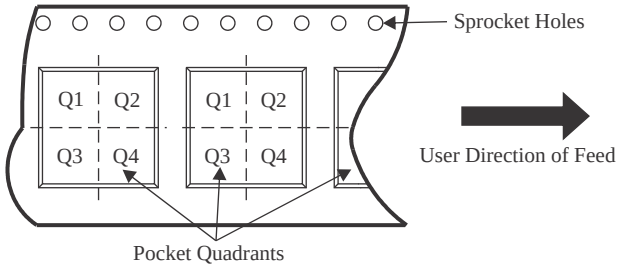


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

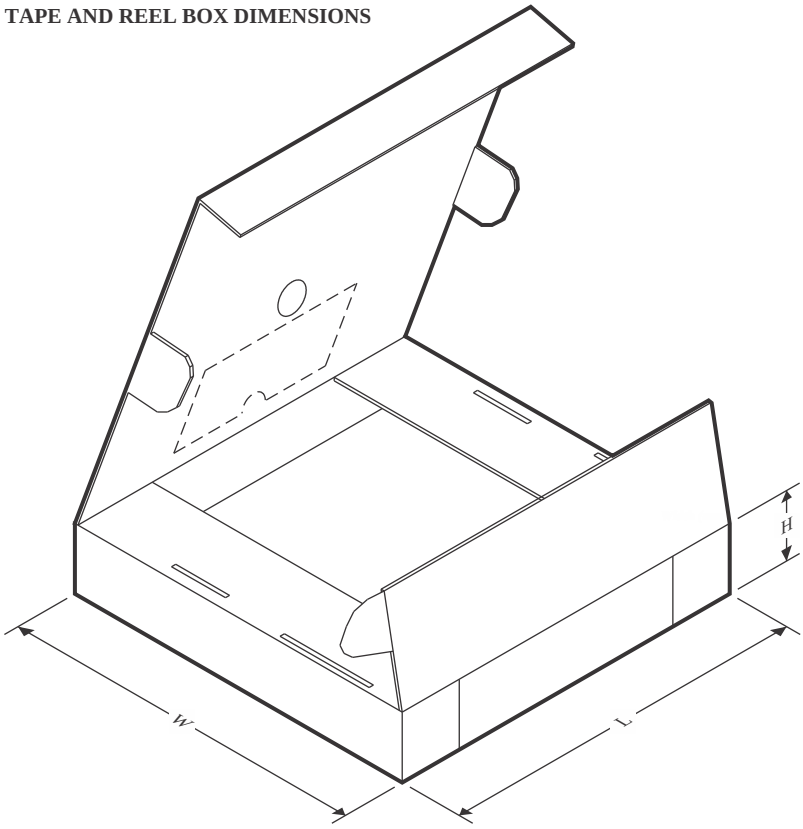
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TRS3232ECDR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
TRS3232ECDWR	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1
TRS3232ECPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
TRS3232EIDBR	SSOP	DB	16	2000	330.0	16.4	8.35	6.6	2.4	12.0	16.0	Q1
TRS3232EIDR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
TRS3232EIDR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
TRS3232EIDRG4	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
TRS3232EIDYYR	SOT-23-THIN	DYY	16	3000	330.0	12.4	4.8	3.6	1.6	8.0	12.0	Q3
TRS3232EIPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
TRS3232EIRGTR	VQFN	RGT	16	3000	330.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2

TAPE AND REEL BOX DIMENSIONS

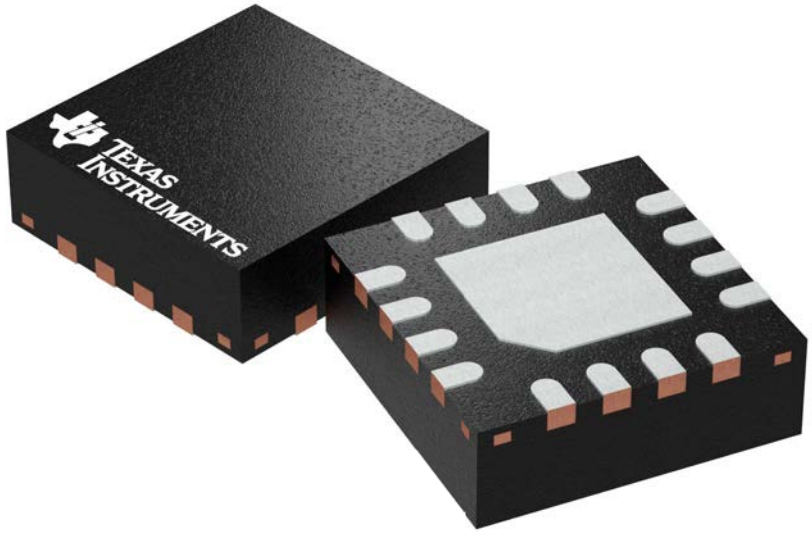


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TRS3232ECDR	SOIC	D	16	2500	353.0	353.0	32.0
TRS3232ECDWR	SOIC	DW	16	2000	350.0	350.0	43.0
TRS3232ECPWR	TSSOP	PW	16	2000	356.0	356.0	35.0
TRS3232EIDBR	SSOP	DB	16	2000	353.0	353.0	32.0
TRS3232EIDR	SOIC	D	16	2500	353.0	353.0	32.0
TRS3232EIDR	SOIC	D	16	2500	353.0	353.0	32.0
TRS3232EIDRG4	SOIC	D	16	2500	353.0	353.0	32.0
TRS3232EIDYYR	SOT-23-THIN	DYY	16	3000	336.6	336.6	31.8
TRS3232EIPWR	TSSOP	PW	16	2000	353.0	353.0	32.0
TRS3232EIRGTR	VQFN	RGT	16	3000	367.0	367.0	35.0

RGT 16 VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



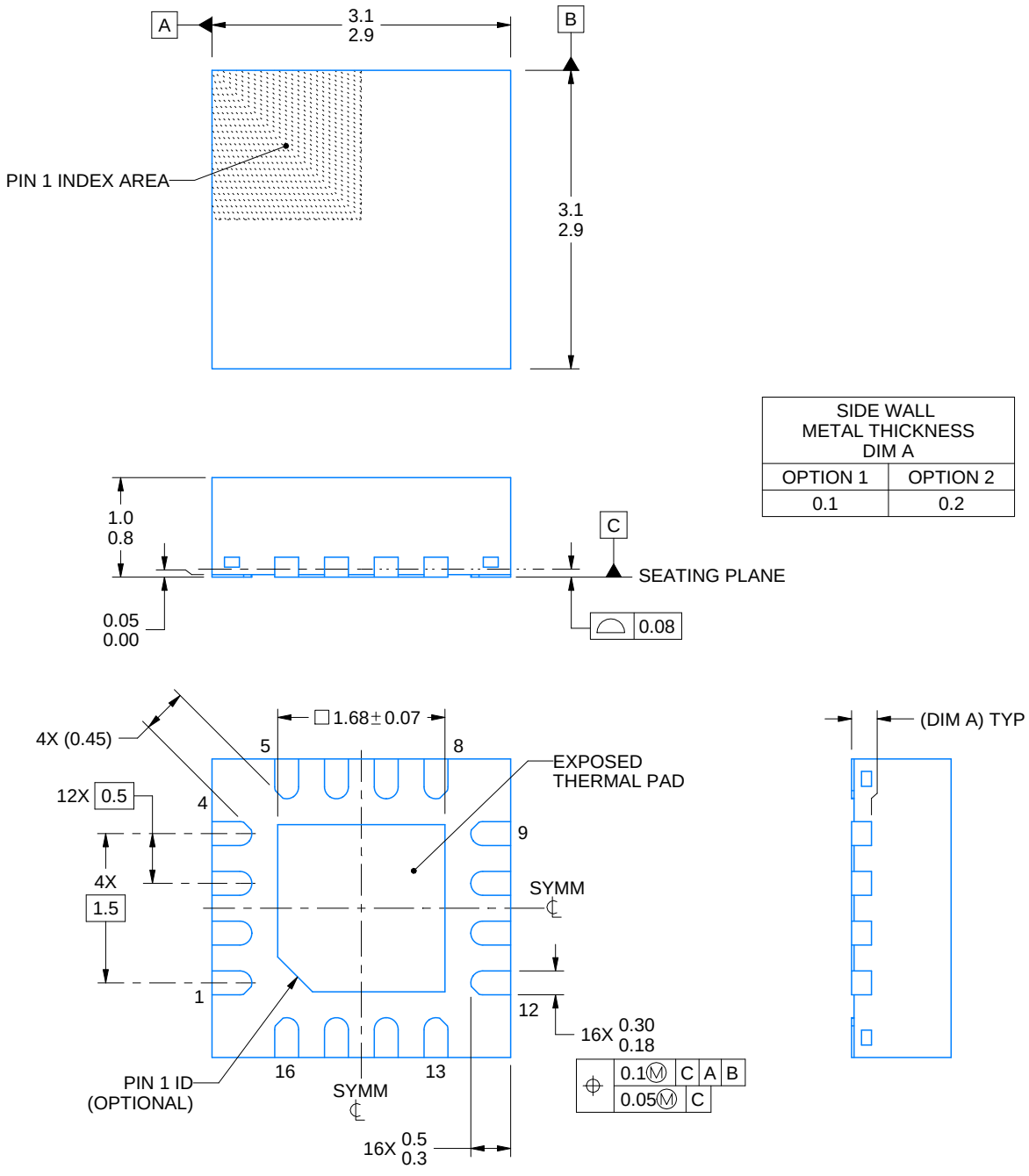
Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

PACKAGE OUTLINE

RGT0016C

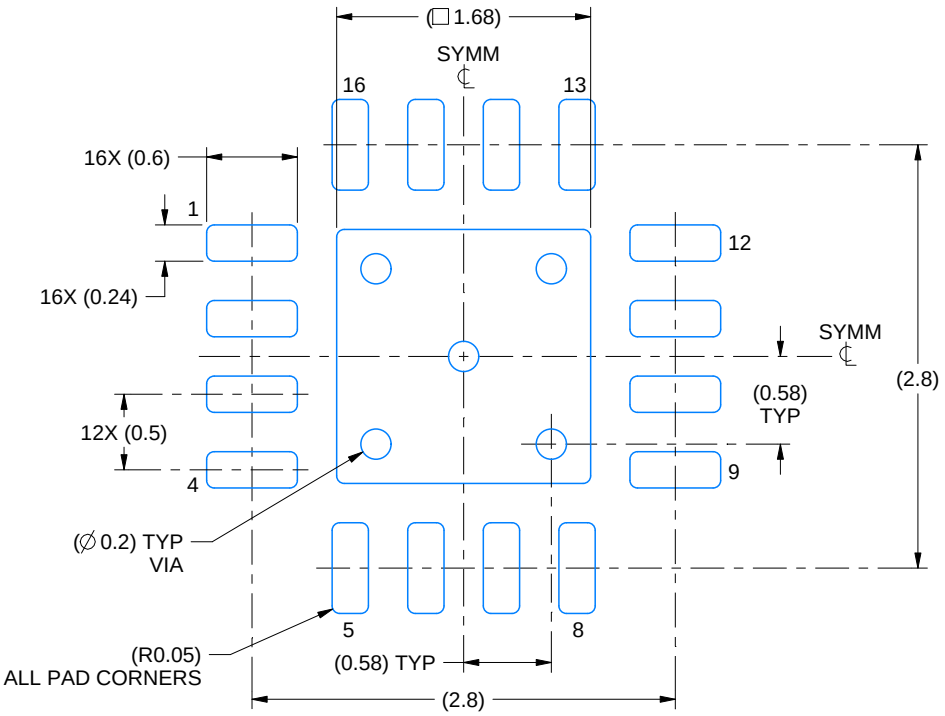
VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD

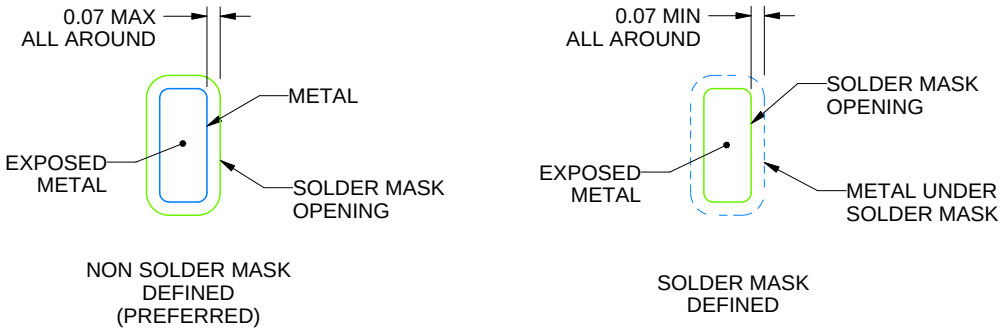


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:20X

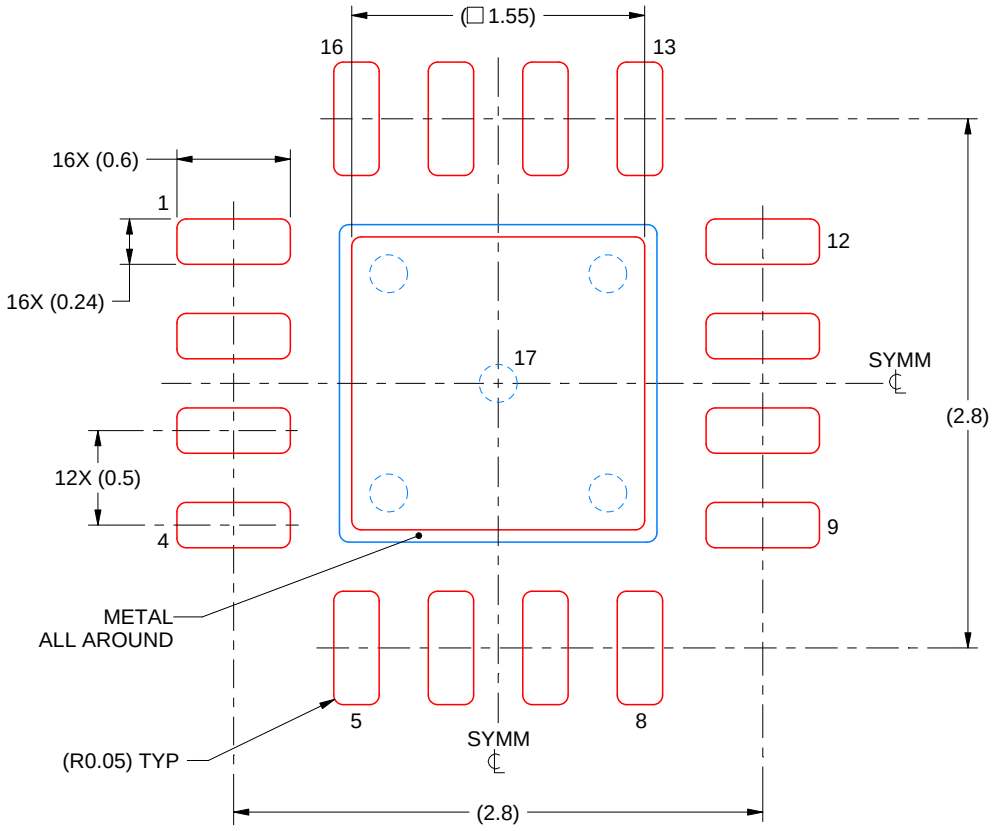


SOLDER MASK DETAILS

4222419/E 07/2025

NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

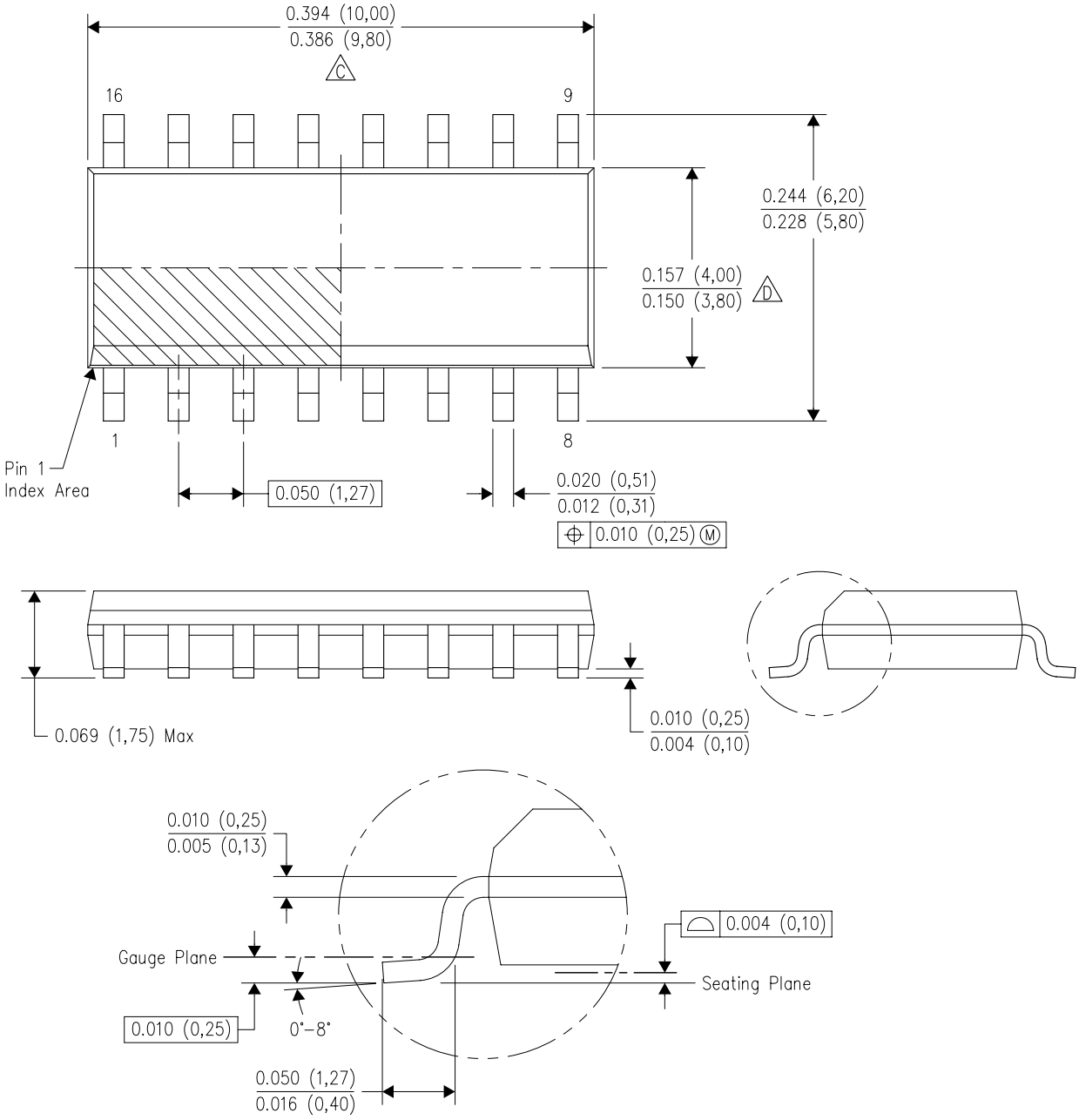
EXPOSED PAD 17:
85% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:25X

4222419/E 07/2025

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

D (R–PDSO–G16) PLASTIC SMALL OUTLINE



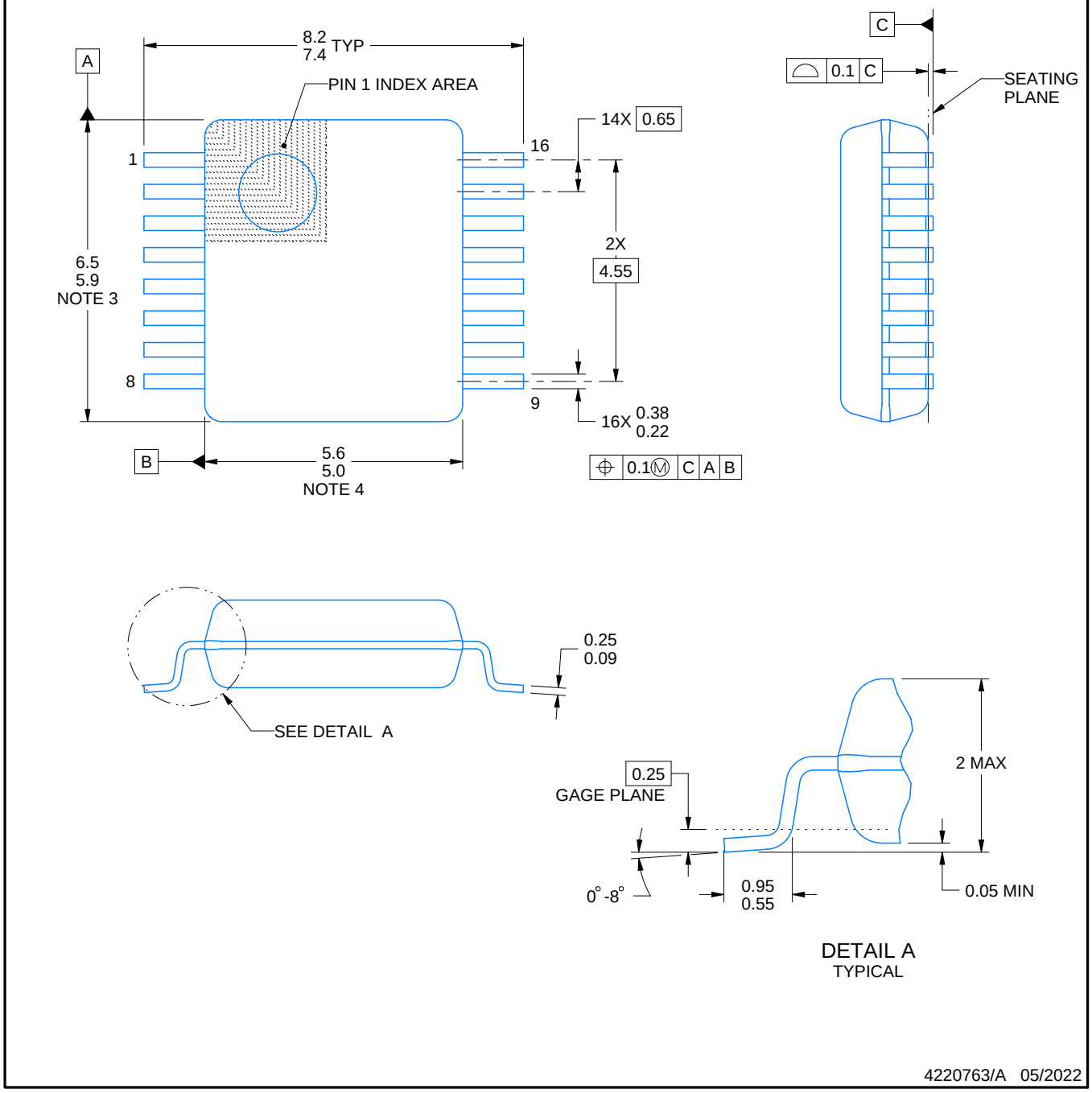
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
E. Reference JEDEC MS–012 variation AC.

PACKAGE OUTLINE

DB0016A

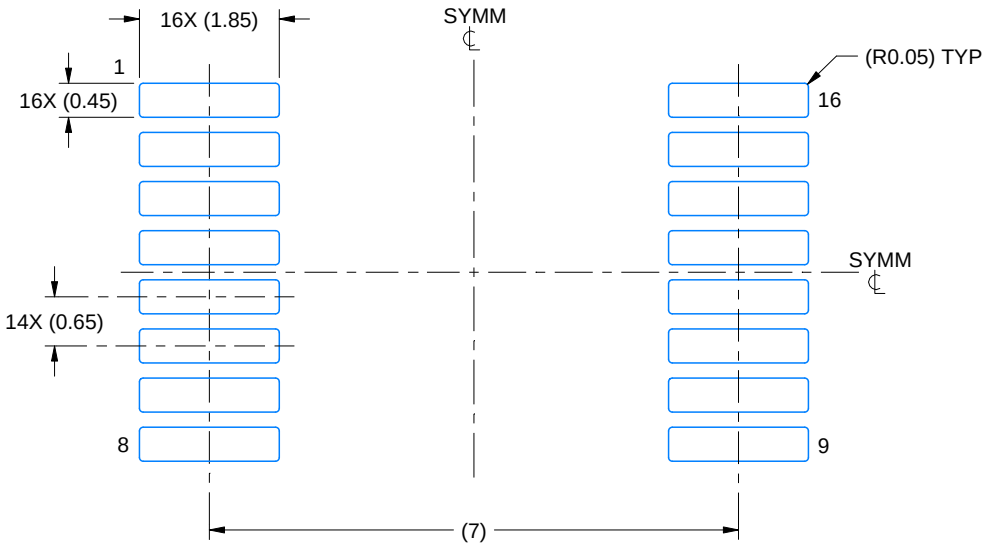
SSOP - 2 mm max height

SMALL OUTLINE PACKAGE

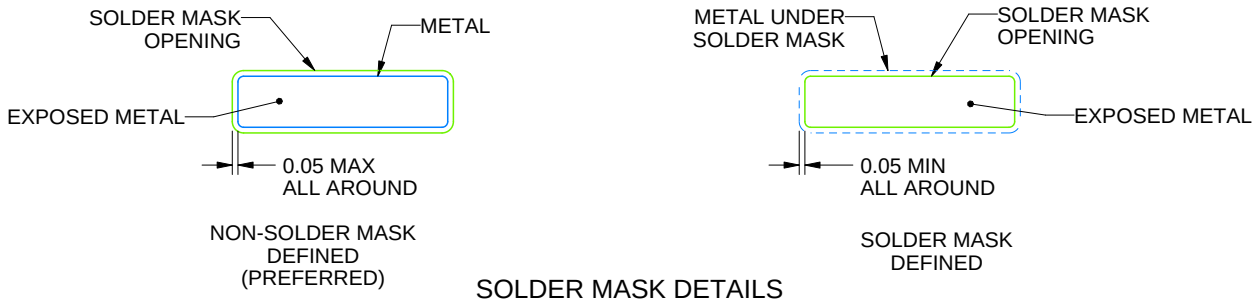


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-150.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

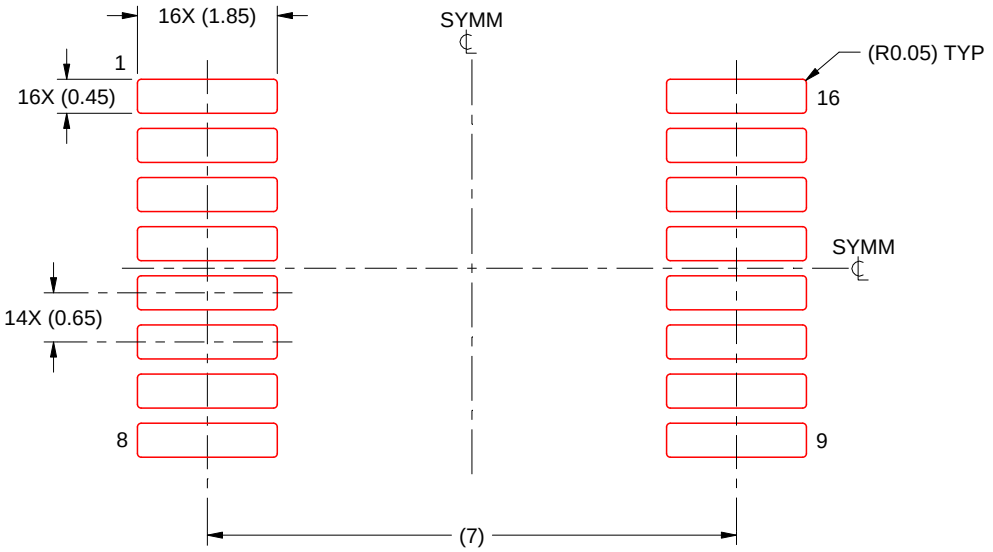


SOLDER MASK DETAILS

4220763/A 05/2022

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220763/A 05/2022

NOTES: (continued)

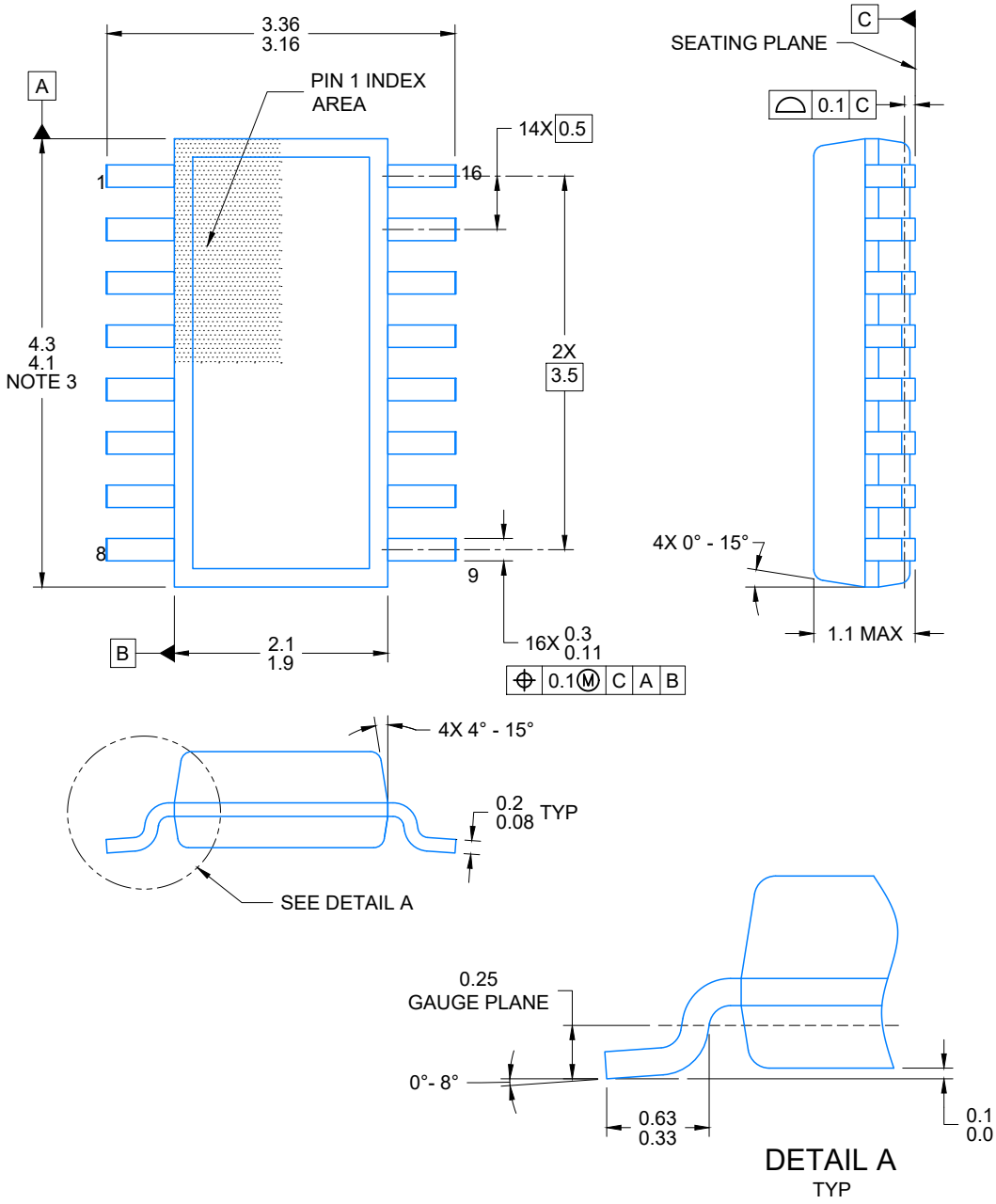
7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

PACKAGE OUTLINE

DYY0016A

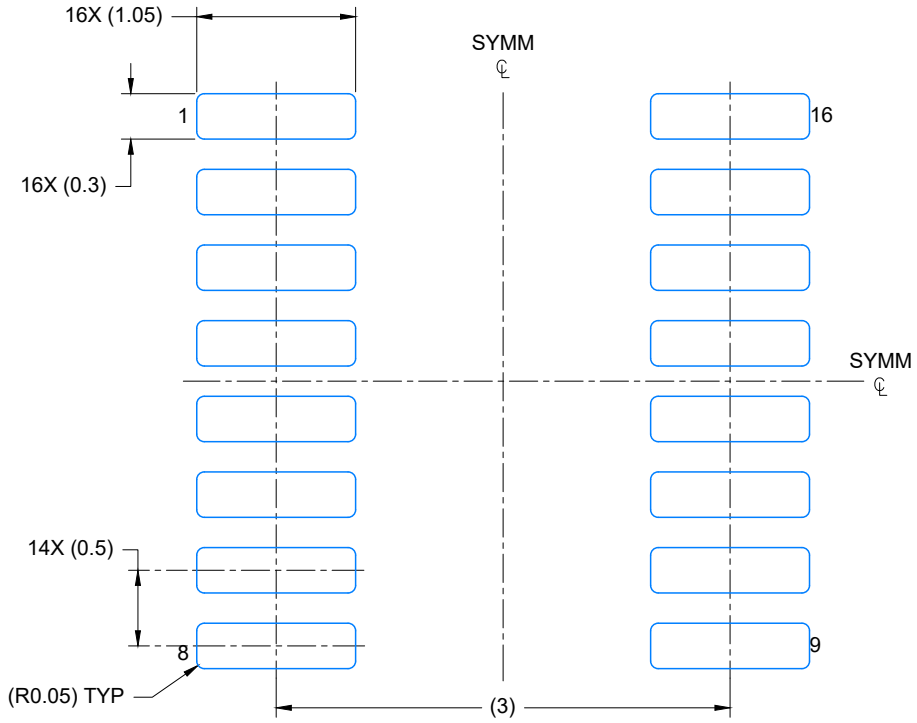
SOT-23-THIN - 1.1 mm max height

PLASTIC SMALL OUTLINE

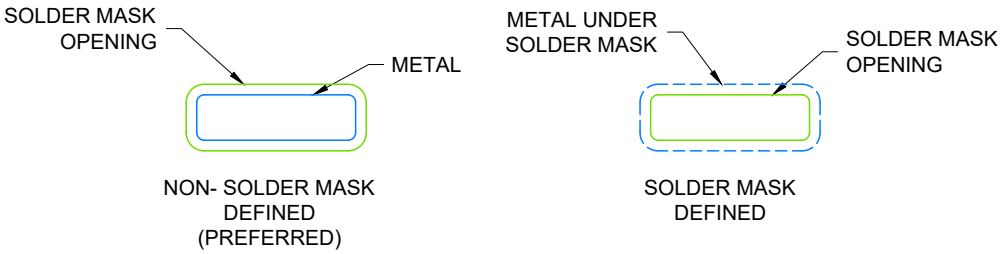


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
5. Reference JEDEC Registration MO-345, Variation AA



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 20X



SOLDER MASK DETAILS

4224642/D 07/2024

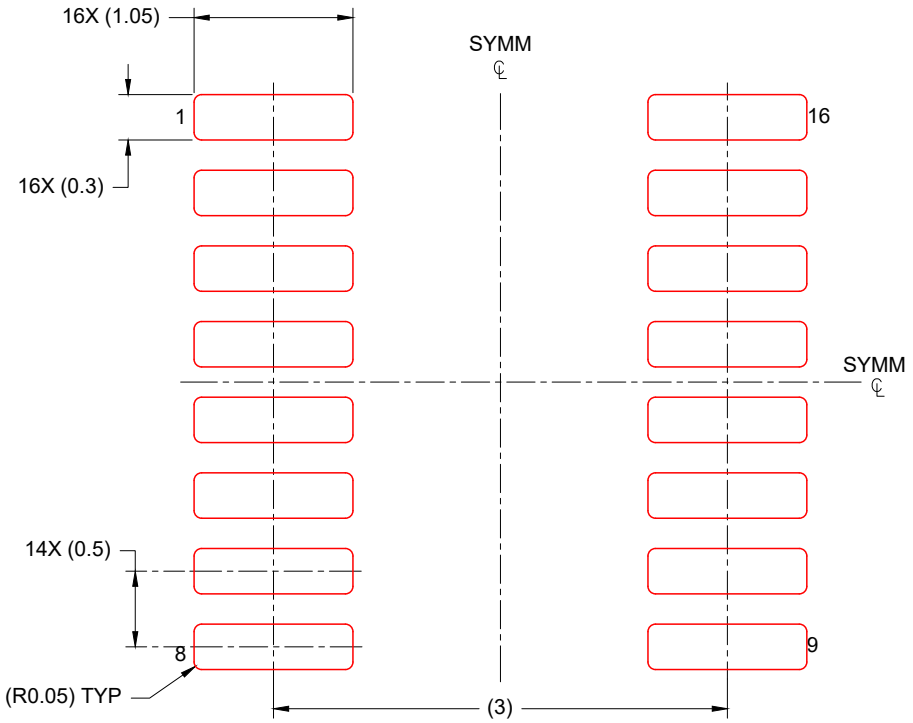
NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

SOT-23-THIN - 1.1 mm max height

PLASTIC SMALL OUTLINE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 20X

4224642/D 07/2024

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

GENERIC PACKAGE VIEW

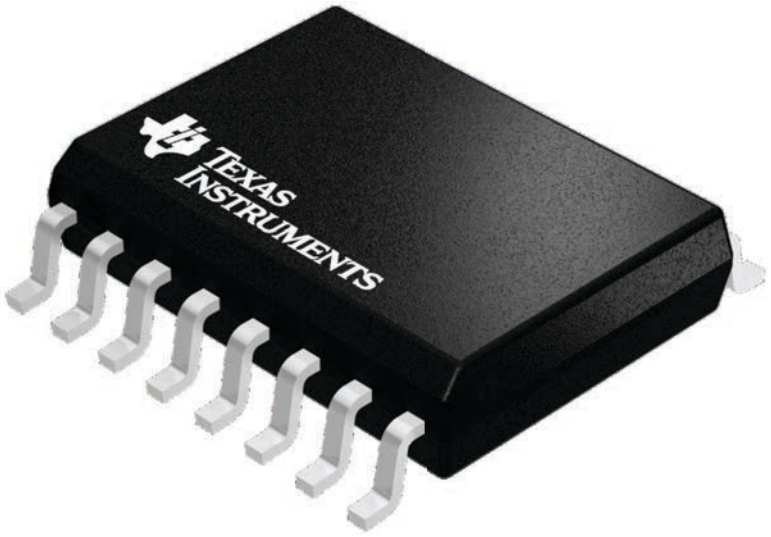
DW 16

SOIC - 2.65 mm max height

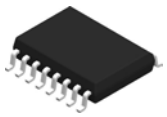
7.5 x 10.3, 1.27 mm pitch

SMALL OUTLINE INTEGRATED CIRCUIT

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



4224780/A

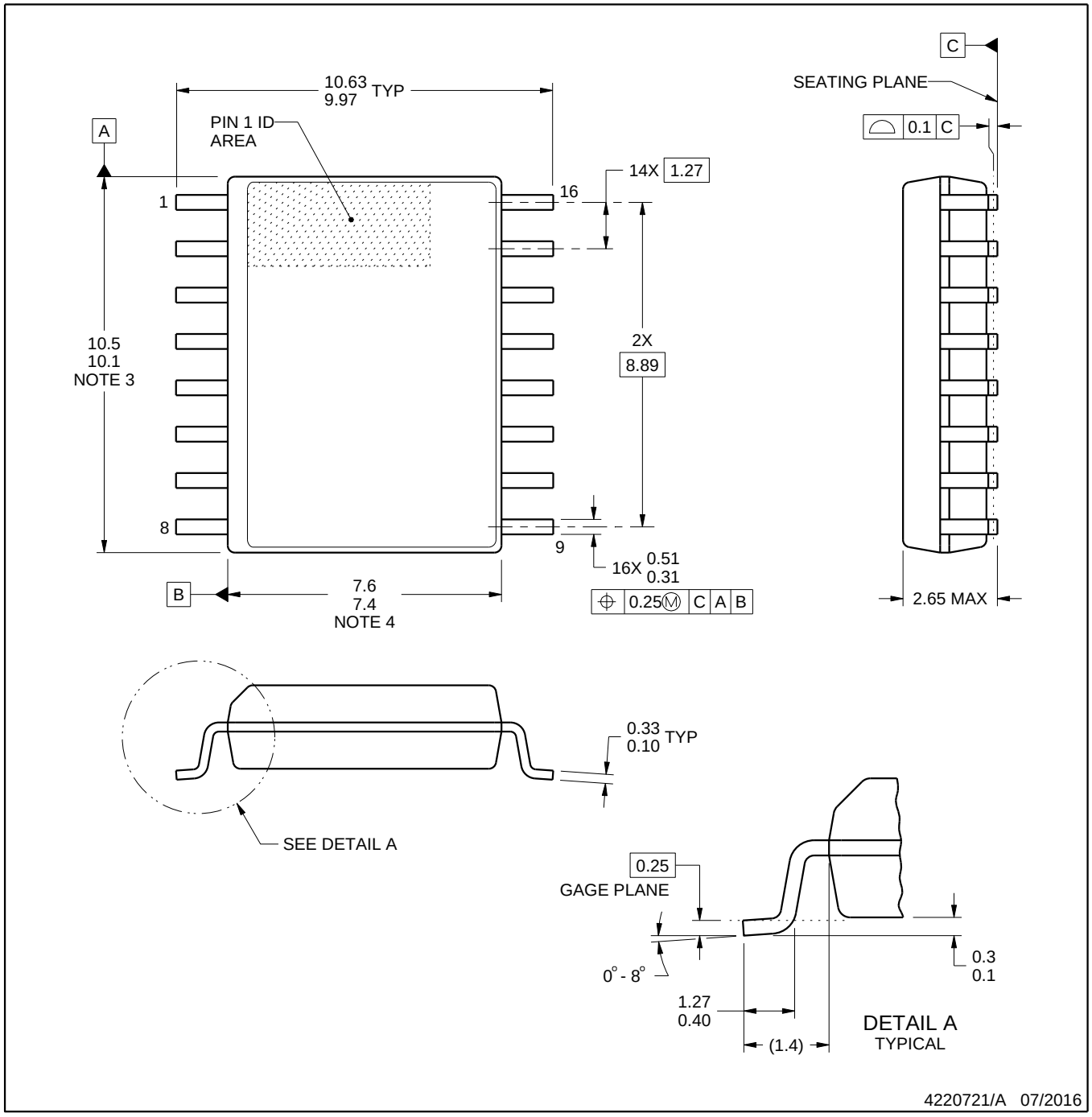


PACKAGE OUTLINE

DW0016A

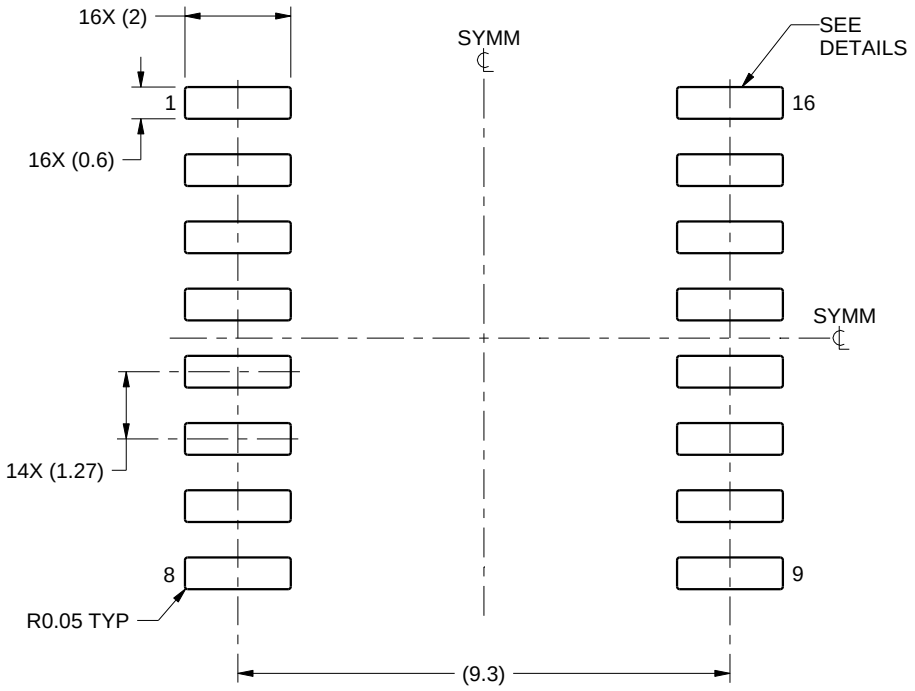
SOIC - 2.65 mm max height

SOIC

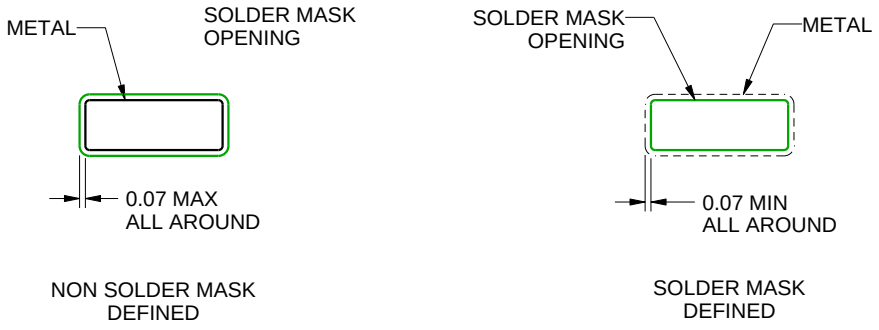


NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm, per side.
5. Reference JEDEC registration MS-013.



LAND PATTERN EXAMPLE
SCALE:7X

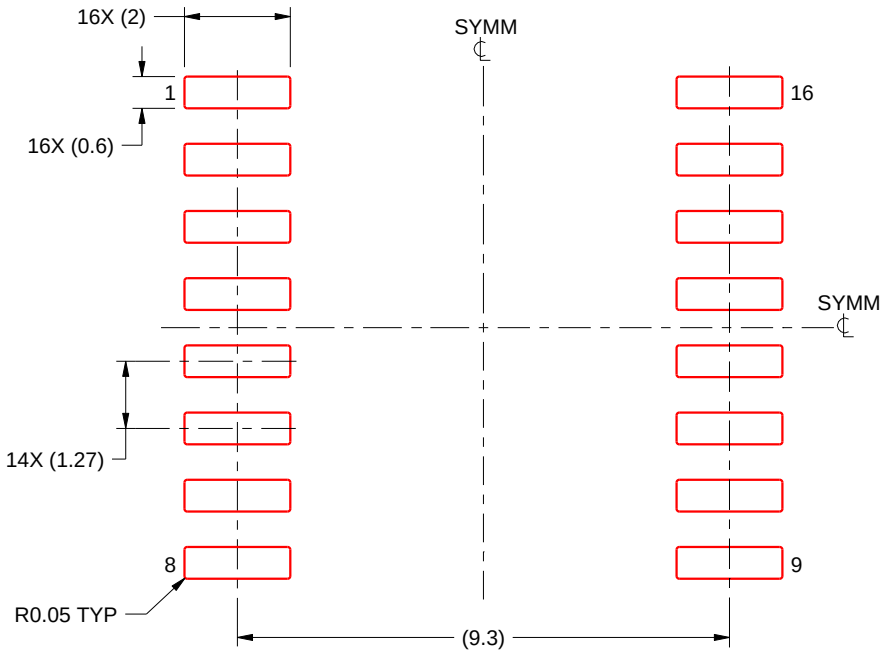


SOLDER MASK DETAILS

4220721/A 07/2016

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:7X

4220721/A 07/2016

NOTES: (continued)

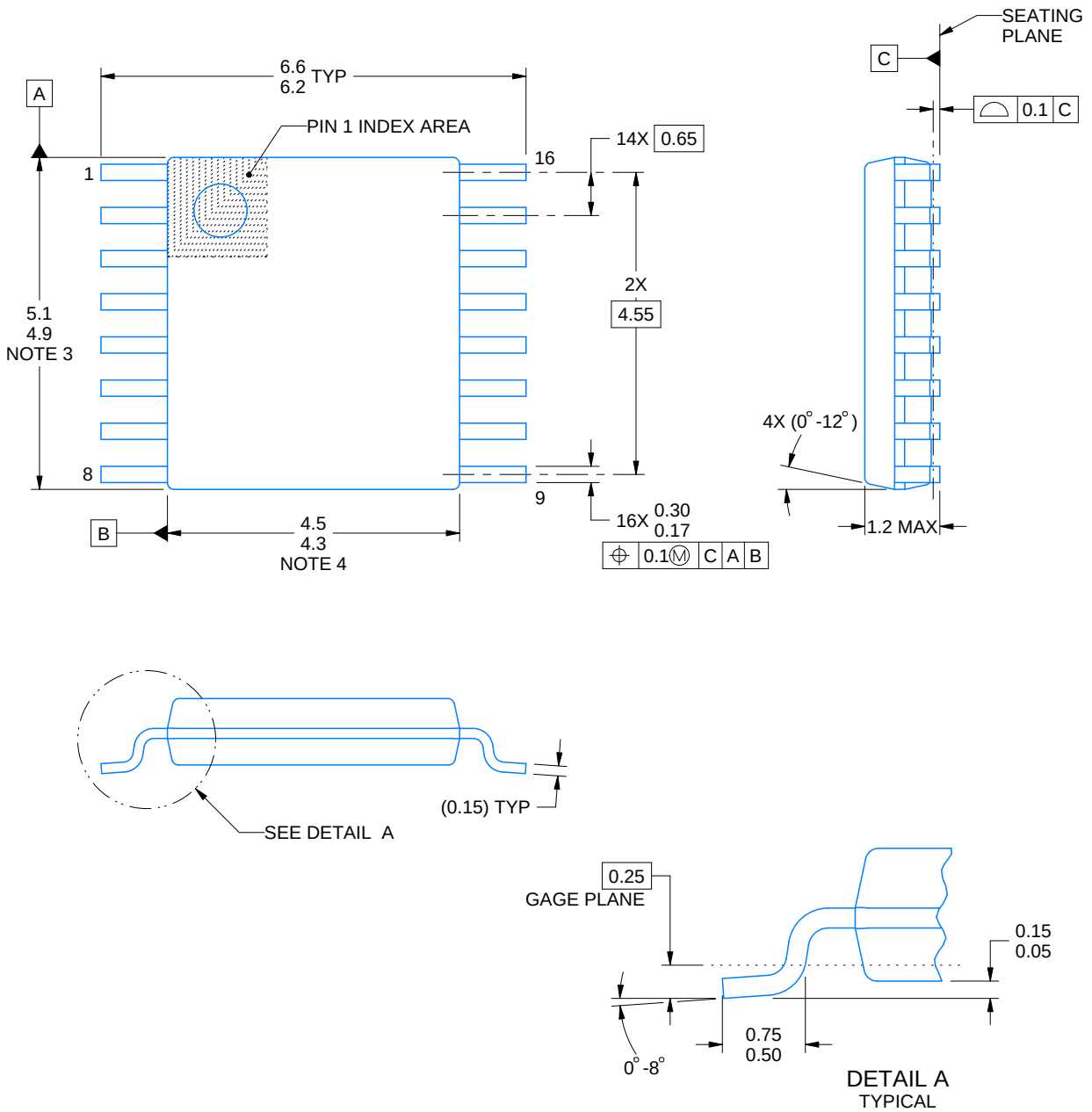
8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

PACKAGE OUTLINE

PW0016A

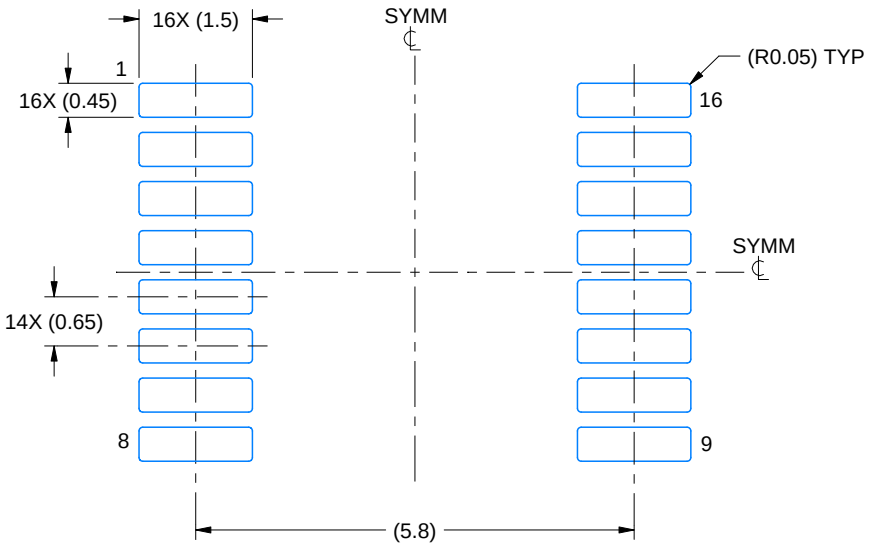
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.



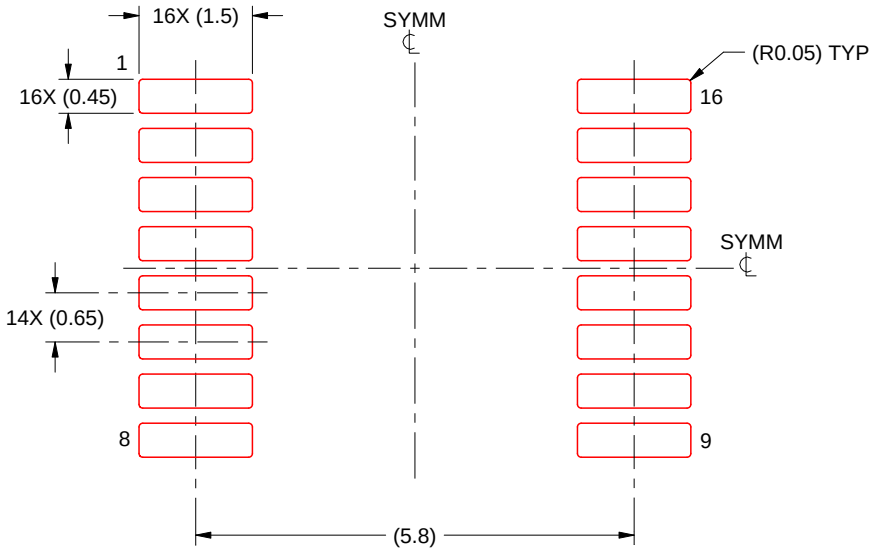
LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

SOLDER MASK DETAILS

4220204/B 12/2023

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220204/B 12/2023

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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最終更新日：2025 年 10 月